Supporting Information

Multifunctional and Ultrasensitive rGO and Pen ink/PVA Decorated Model/Spandex Fabric for High-performance Wearable Sensors

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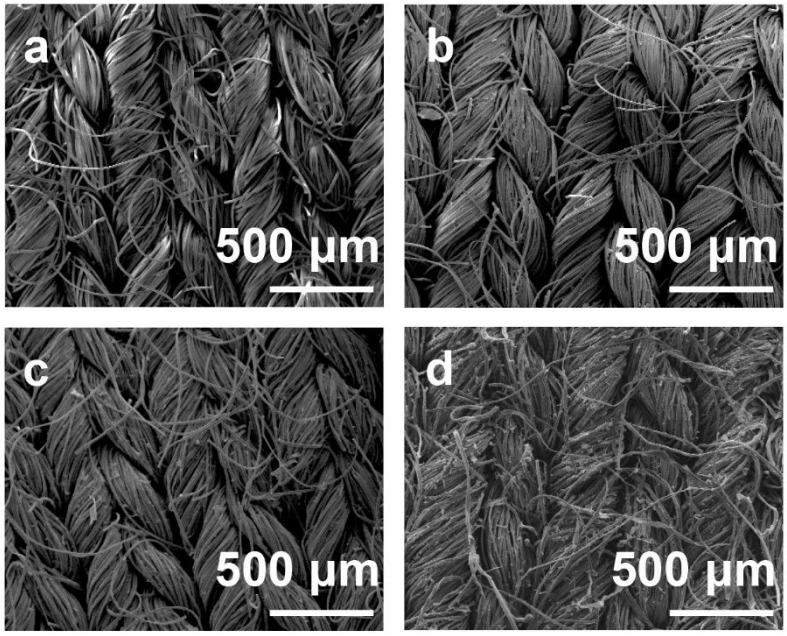

Figure S1. a-d) FE-SEM images of MS with different GO concentrations of 0.5 mg·ml^{-1}, 1.0 mg·ml^{-1}, 1.5 mg·ml^{-1} and 2.0 mg·ml^{-1}, respectively. The surface of fibers becomes rougher with the increment of GO concentration.

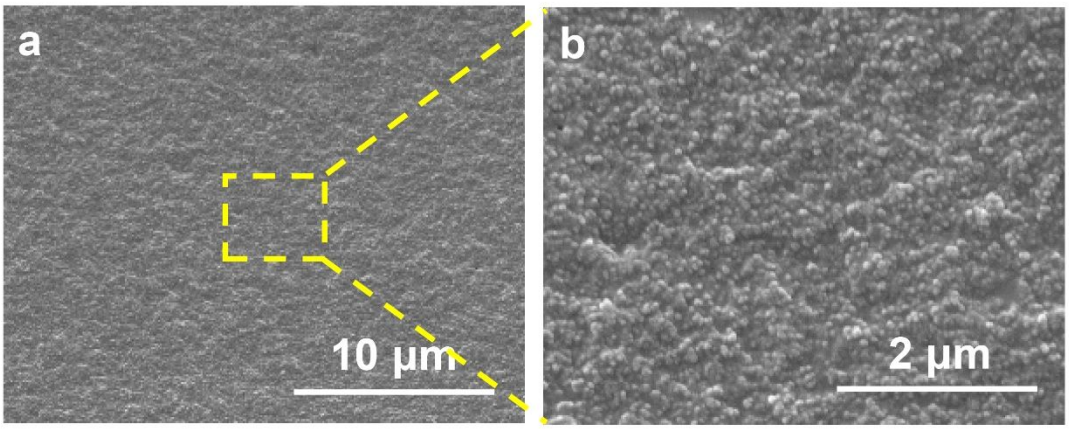

Figure S2. a-b) FE-SEM images of MRIP at different magnifications. The surface shows a porous microstructure and gully morphology.

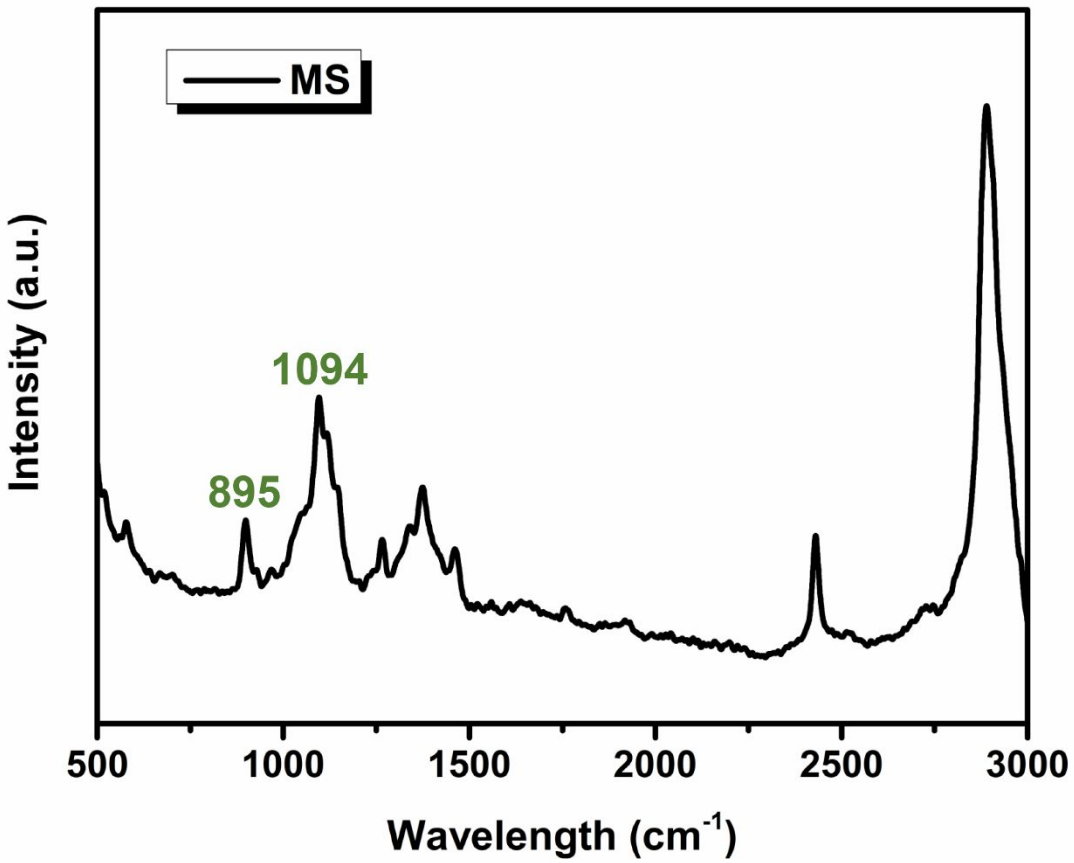

Figure S3. Raman spectra of MS. Bands located at about 895 cm^{-1} and 1094 cm^{-1} are two characteristic peaks of cellulose, which give rise to cellulose C-O ring stretching and angle bending of mixed modes (C-C-C, C-H-O) respectively.

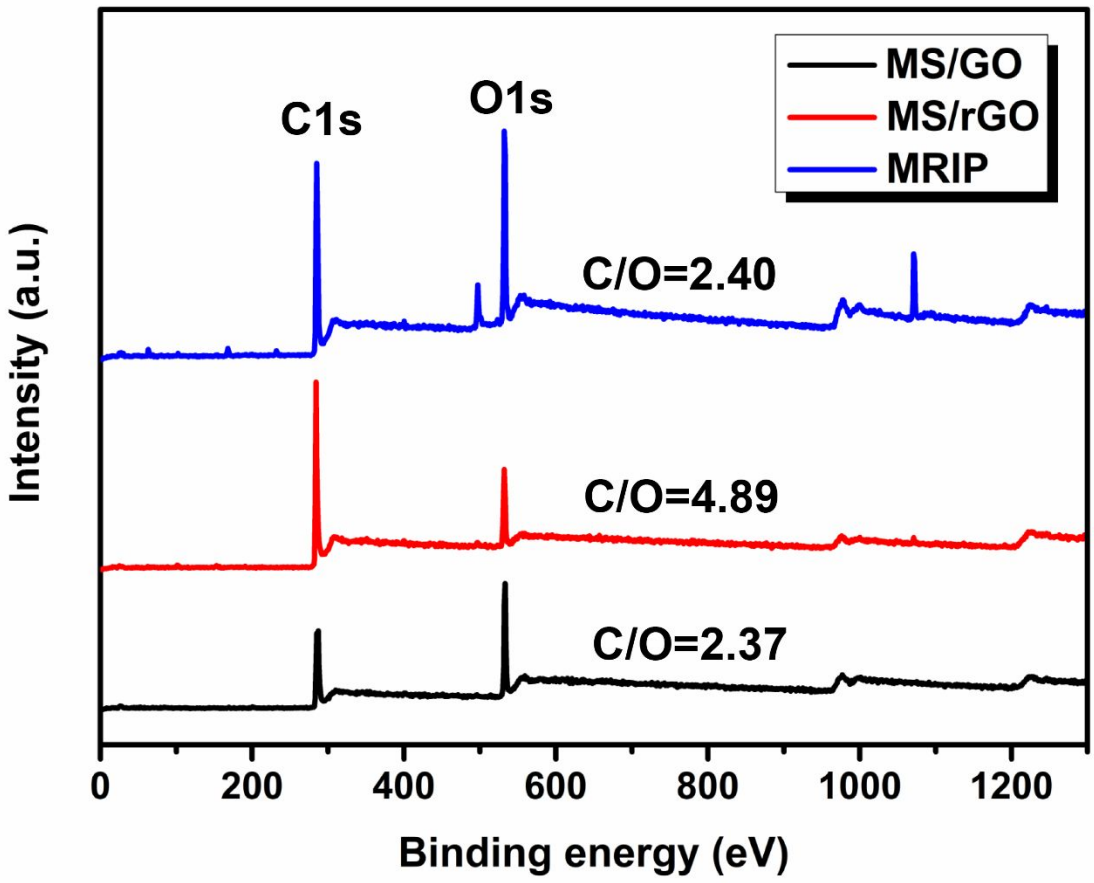

Figure S4. XPS spectra of MS/GO1.5, MS/rGO1.5 and MRIP8. The main elements of C and O are obviously seen in XPS survey spectra.

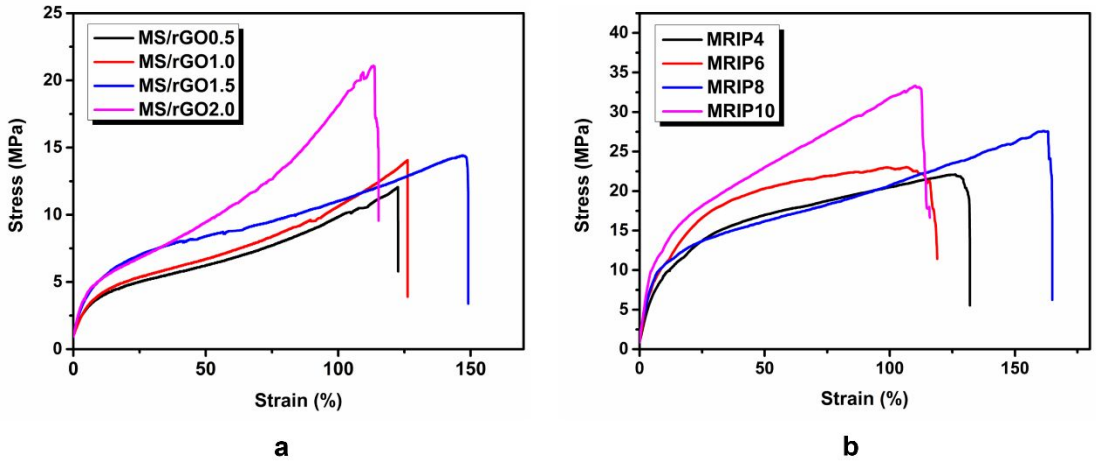

Figure S5. a) Stress-strain curve of MS/rGO with different concentrations of GO and b) MRIP with different concentrations of carbonic pen ink.

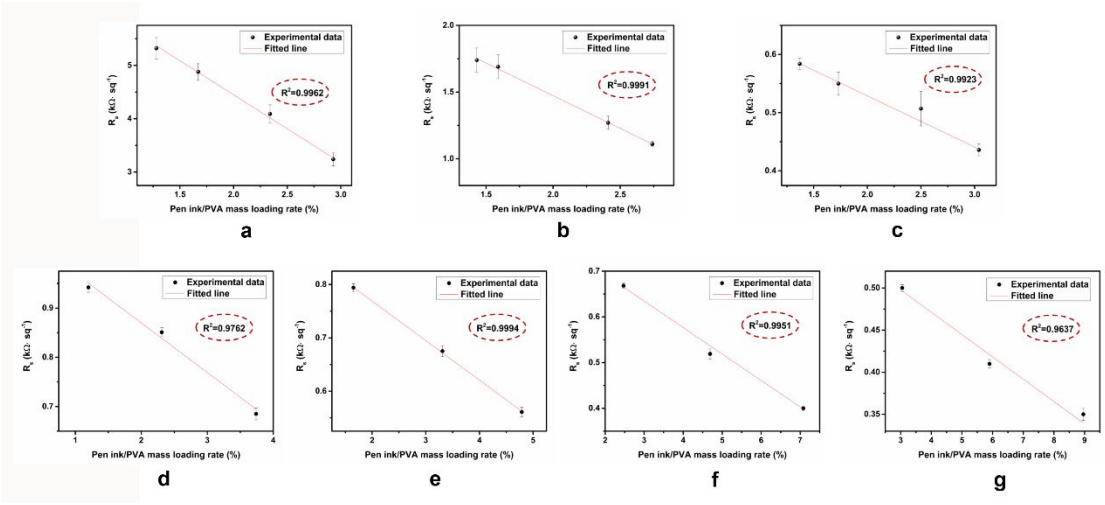

Figure S6. Electrical conductivity of MRIP versus pen ink/PVA mass loading rate. Surface resistance variations of MRIP based on MS/rGO0.5 (a), MS/rGO1.0 (b) and MS/rGO2.0 (c) versus pen ink/PVA mass loading rate at different pen ink concentrations of 4 wt.%, 6 wt.%, 8 wt.% and 10 wt.%. Surface resistance variations of MRIP at different pen ink concentrations of 4 wt.% (d), 6 wt.% (e), 8 wt.% (f) and 10 wt.% (g) versus pen ink/PVA mass loading rate by dipping times of 1, 2 and 3 times in pen ink solution.

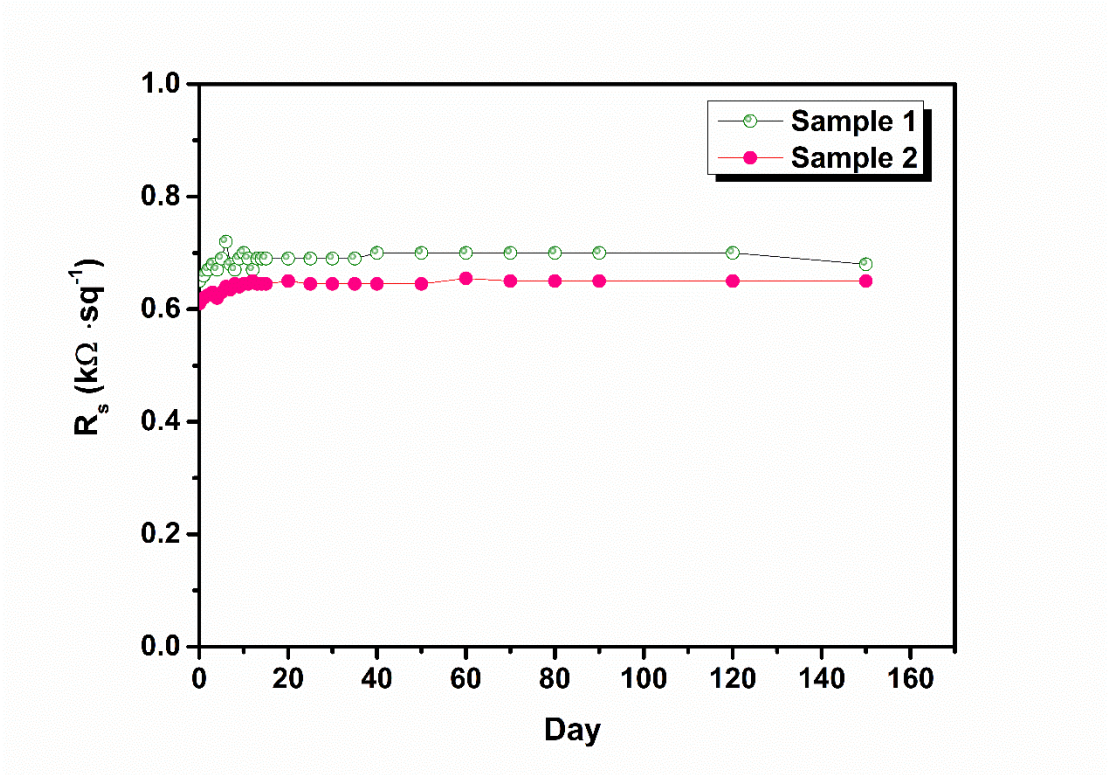

Figure S7. Surface resistance variations of two MRIP8 fabric samples within 5 months in ambient environment.

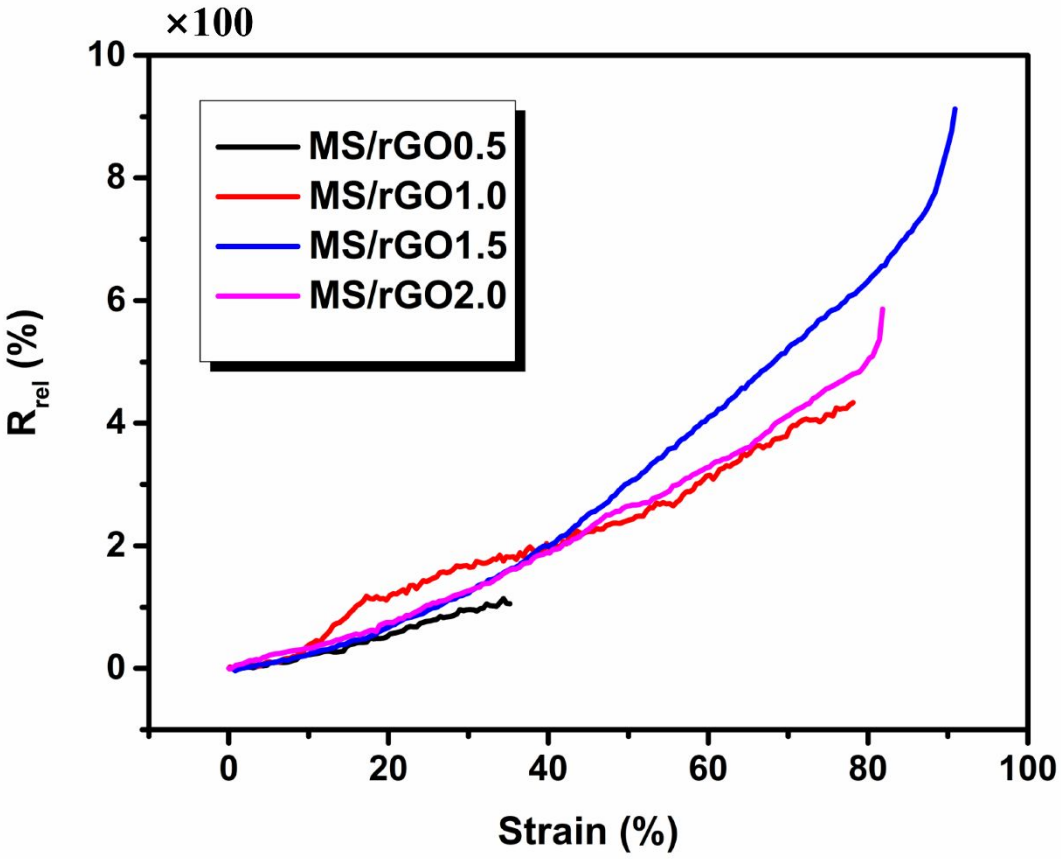

Figure S8. Relative resistance variation of MS/rGO0.5, MS/rGO1.0, MS/rGO1.5 and MS/rGO2.0 versus strain, respectively.

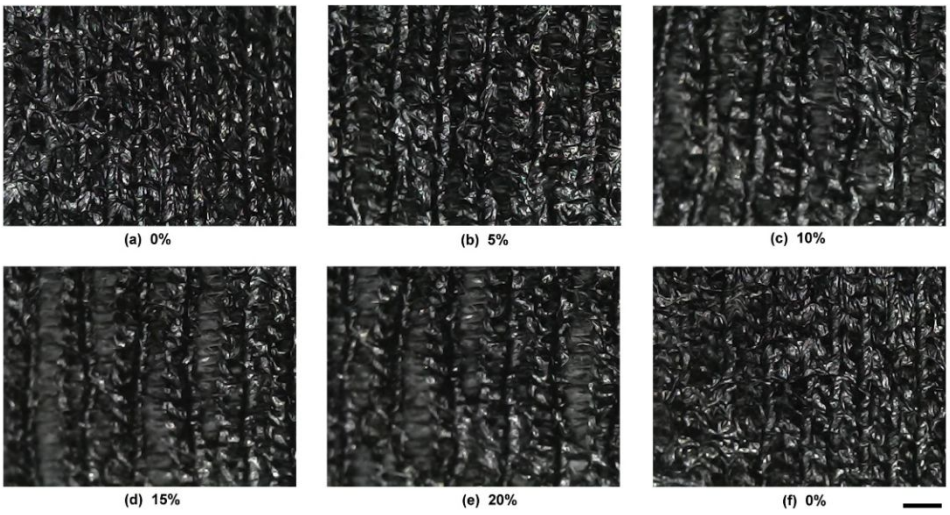

Figure S9. The optical images of MRIP under 0%, 5%, 10%, 15%, 20% and 0% strain levels, respectively.

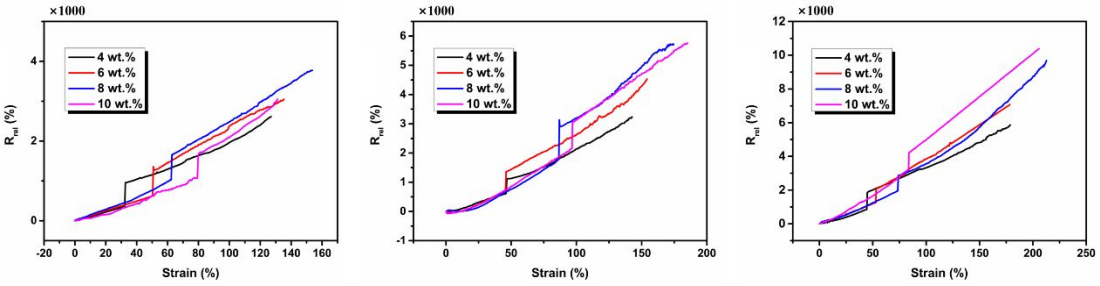

Figure S10. Strain sensing performance of MRIP with various pen ink concentrations (4 wt.%, 6 wt.%, 8 wt.% and 10 wt.%) based on MS/rGO0.5 (a), MS/rGO1.0 (b) and MS/rGO2.0 (c), respectively.

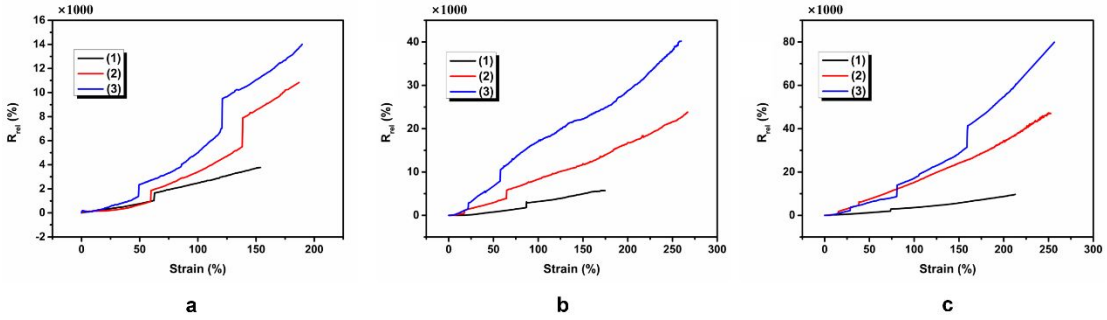

Figure S11. Relative resistance variation of MRIP with 4 wt.% (a), 6 wt.% (b) and 10 wt.% (c) with different pin ink/PVA layers (one to three dip-coating times) as a function of strain.

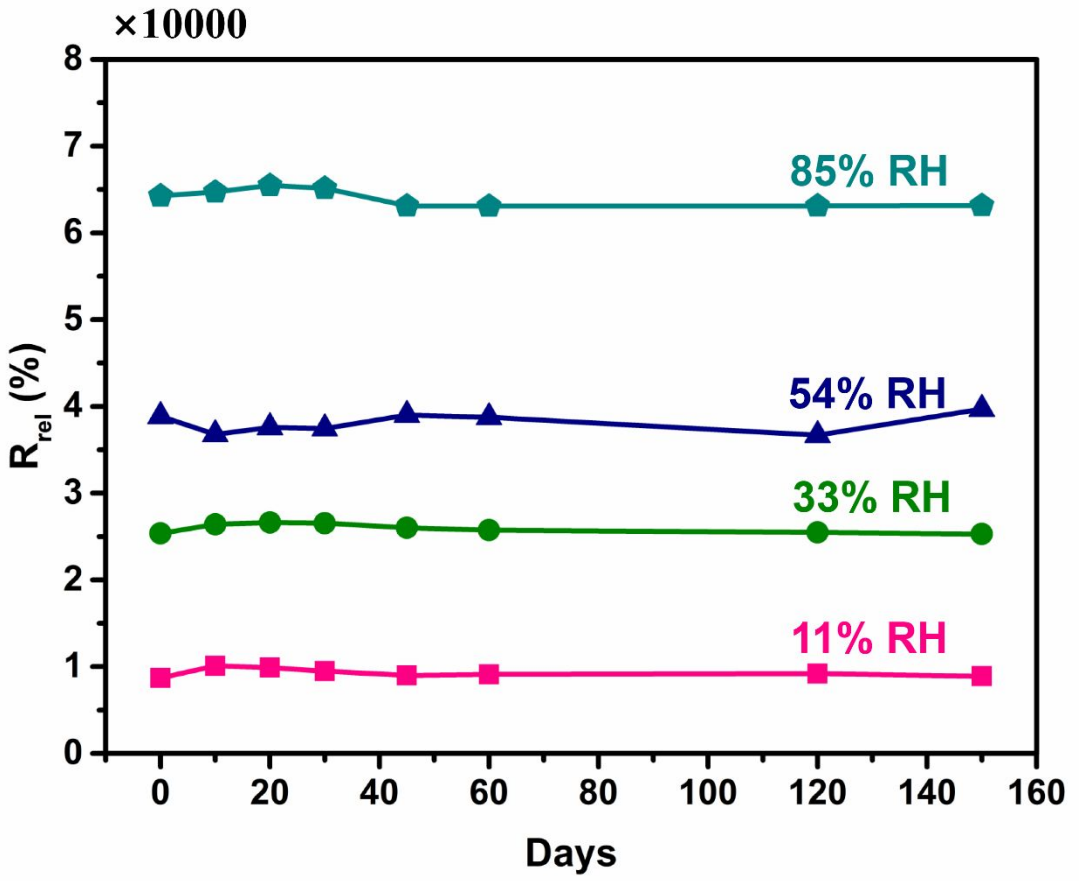

Figure S12. Long-term stability of MRIP8(3) exposed to various RH conditions within five months.

Table S1 The GF and sensing range of MRIP

Sample	Stage	GF	Sensing range (%)
MS/rGO0.5	1	3.4	35
MS/rGO1.0	1	5.4	78
MS/rGO1.5	1	9.1	91
MS/rGO2.0	1	6.4	81
MRIP0.5-4	1	11.4	32
	2	17.0	127
MRIP0.5-6	1	12.3	50
	2	21.6	135
MRIP0.5-8	1	15.9	62
	2	23.7	154
MRIP0.5-10	1	14.2	79
	2	25.6	131
MRIP1.0-4	1	14.6	46
	2	22.9	143
MRIP1.0-6	1	17.8	46
	2	27.6	154
MRIP1.0-8	1	22.0	87
	2	35.4	175
MRIP1.0-10	1	24.5	97
	2	31.3	185

MRIP1.5-4	1	18.2	42
	2	48.5	154
MRIP1.5-6	1	26.8	43
	2	71.0	158
MRIP1.5-8	1	36.9	67
	2	100.9	293
MRIP1.5-10	1	31.6	79
	2	81.0	293
MRIP2.0-4	1	19.1	45
	2	29.1	179
MRIP2.0-6	1	23.0	53
	2	40.4	178
MRIP2.0-8	1	26.5	74
	2	49.6	213
MRIP2.0-10	1	38.8	83
	2	50.9	206
MRIP0.5-8-2□	1	13.6	59
	2	46.2	138
	3	62.0	187
MRIP0.5-8-3	1	26.2	49
	2	63.9	121
	3	63.8	190

MRIP1.0-8-2	1	30.8	17
	2	58.4	64
	3	86.8	267
MRIP1.0-8-3	1	71.3	22
	2	141.4	58
	3	134.0	295
MRIP1.5-8-2	1	179.0	49
	2	212.5	132
	3	264.6	300
MRIP1.5-8-3	1	213.0	33
	2	315.1	84
	3	492.8	300
MRIP2.0-8-2	1	45.8	15
	2	126.0	38
	3	191.1	267
MRIP2.0-8-3	1	83.4	28
	2	98.1	81
	3	221.1	159
		407.0	267

The first number means the concentration of GO, the second number means the concentration of pen ink and the third number means the dipping time of pen ink/PVA layer. The concentration of PVA is designed at 1 wt.% for stain sensing measurement.

Table S2

The strain and humidity sensitivities of MRIP after various washing procedures.

Washing cycles	Maximum Strain sensitivity	Humidity sensitivity
0	492.8	765.1
1	487.9	771.3
2	481.2	776.6
3	474.3	780.4
6	495.7	781.1
9	486.8	769.2
12	467.5	754.9

Table S3

The permeability of MRIP.

Sample	Permeability (mm/s)
MS	986.94 ± 15.983
MRIP8	787.65 ± 20.465
MRIP8(2)	535.96 ± 22.017
MRIP8(3)	353.28 ± 18.214